UNDERSTANDING SCATTER PLOTS

1. Eliseo performed a study to explore how TV viewing habits affect student performance. He collected data by surveying several students in his math class. He asked each student to provide their current math mark as well as the number of hours spent watching TV each day. The data are summarized in the following table:

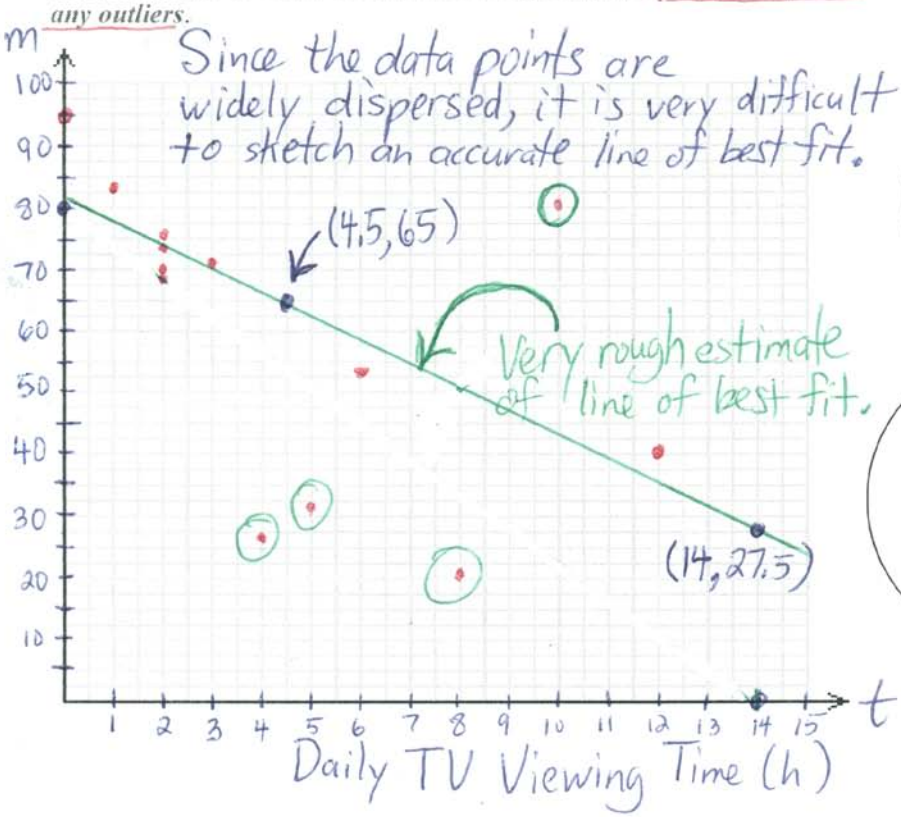
Daily TV Viewing Time (h)	1	6	3	2	10	0	2	5	2	12	8	5	2	4
Mark (%)	83	53	71	73	81	95	68	51	70	40	21	32	75	27

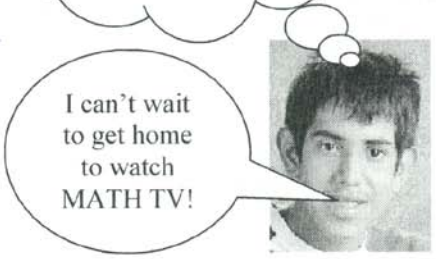
(a) State the independent and dependent variable.

SaherSami

Independent: TV Viewing Time **Dependent:** Mark

(b) Create a *scatter plot* of the data (plot the data points). ***Do not connect the dots!*** Label the axes and include a title for your graph. In addition, *circle any outliers*.





(c) Describe the relationship between the students' daily TV viewing time and their mathematics marks.

The math mark tends to decrease with increased TV viewing time.

(d) Draw a line of best fit. Then write the slope-intercept equation for the line of best fit. Show your work!

$\text{slope} = \frac{\Delta m}{\Delta t} = \frac{m_2 - m_1}{t_2 - t_1} = \frac{27.5 - 65}{14 - 4.5} \doteq -3.9$

(calculated using points identified on graph)

→ estimated from graph

Equation of Line of Best Fit: $m = -3.9t + 81$

(e) Use the equation of your line of best fit to estimate the math mark of a student who watches four hours of TV per day. $t = 4,\ m = ?$

$m = -3.9(4) + 81 \doteq 65$

The estimated mark for a student who watches four hours of TV daily is about 65%

(f) Again using your equation, estimate the number of hours of TV watched by a student with a mark of 45%.

$t = ?,\ m = 45$

$45 = -3.9t + 81$

$\therefore -3.9t = 45 - 81$

$\therefore t = \frac{-36}{-3.9} \doteq 9$

The line of best fit predicts about 9 hours of TV viewing per day.

(g) How certain are you that your estimates are accurate?

The estimates are not very accurate because there is a large degree of variation in the data.

(h) Now check your answers to (e) and (f) by using your graph.

Equation Answer	*Graph Answer*	*Do the answers agree?*
(e) 65%	(e) 66%	Yes, there is close agreement.
(f) 9 hours	(f) 9.5 hours	Yes, " " " "

2. Now use TI-Interactive to create a scatter plot and to determine the line of best fit for the same data given in question 1. Print out the TI-Interactive document that you create and staple it to this sheet. In addition, summarize your results below.

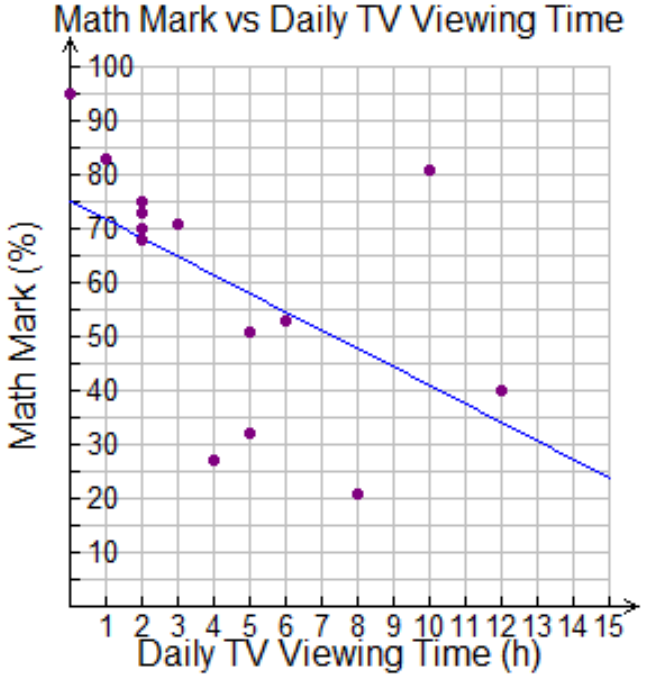
Equation obtained using your line of best fit: $m = -3.9t + 81$

Equation obtained using TI-Interactive: $m = -3.4t + 75$

3. Complete the following table. Use point form.

Similarities between Unit Four and Unit Five	*Differences between Unit Four and Unit Five*
• both units involve graphing on a Cartesian plane • both units involve linear relations • both units involve independent and dependent variables • both units involve slope and intercepts	• In unit 5, the relations were EXACTLY described by an equation. Once one of the variables is given a value, the value of the other can be calculated EXACTLY using the equation • In unit 6, data are collected for the purpose of finding out the strength of the relationship between two variables. The equations of the lines of best fit only allow us to ESTIMATE!

L1	L2
3	71
2	73
10	81
0	95
2	68
5	51
2	70
12	40
8	21
5	32
2	75
4	27



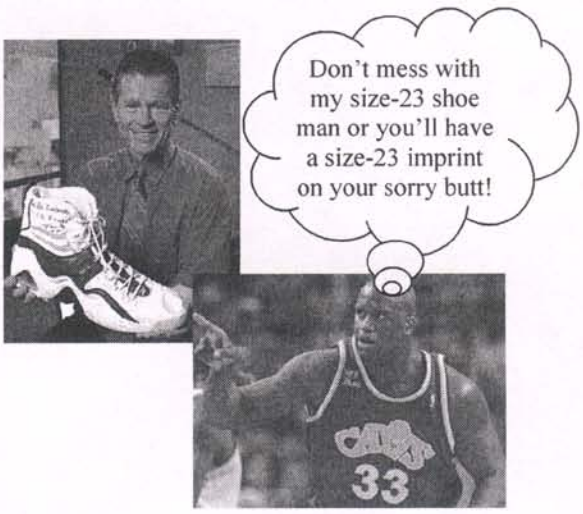
Linear Regression (ax+b)

regEQ(x) = -3.42566x + 75.1708

UNDERSTANDING SCATTER PLOTS #2

Predicting Shaquille O'Neal's Hand Span

In this activity you will collect data by measuring foot lengths and hand spans. You will then use your data to predict Shaquille O'Neal's hand span.



Step One – Calculating Shaq's Foot Length in Centimetres

It is well known that Shaquille O'Neal (also known as "Shaq") wears a size-23 shoe. What is not well known is his foot length in centimetres. Luckily, there are formulas that relate shoe size, as measured with a Brannock device (see diagram below and to the right), to foot length, in inches.

$m \rightarrow$ represents men's shoe size as measured by a Brannock device

$w \rightarrow$ represents women's shoe size as measured by a Brannock device

$f \rightarrow$ represents foot length ***in inches***

$$\boxed{m = 3f - 22} \qquad \boxed{w = 3f - 21}$$

(a) Use the appropriate formula above to calculate Shaq's foot length ***in inches***. Show all work!

$m = 23,\ f = ?$

$\therefore\ 23 = 3f - 22$

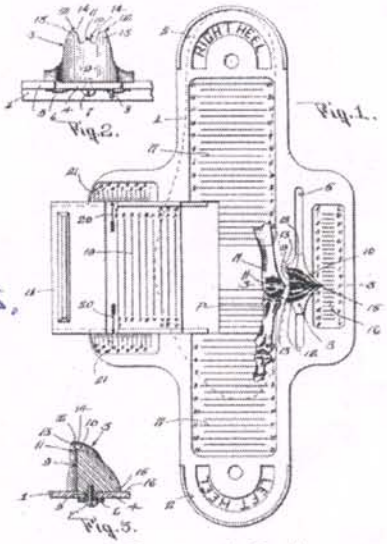
$\therefore\ 23 + 22 = 3f - 22 + 22$

$\therefore\ 45 = 3f$

$\therefore\ \frac{45}{3} = \frac{3f}{3}$

$\therefore\ 15 = f$

Shaquille O'Neal's foot length is about 15 inches.



A Brannock Device

(b) Now convert Shaq's foot length ***to centimetres*** by using the equation $C = 2.54I$, where C represents the length in centimetres and I represents the length in inches.

$I = 15,\ C = ?$

$\therefore\ C = 2.54(15)$

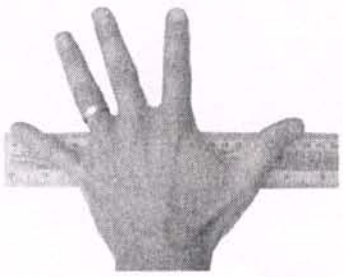
$= 38.1$

Conclusion: Shaq's foot length in cm is about 38.1 cm.

Step Two – Collecting the Data by Measuring Hand Span and Foot Length

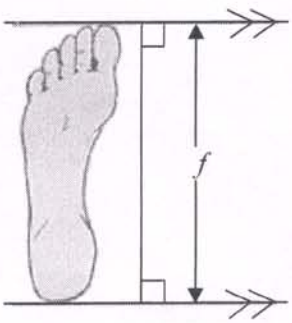
How to Measure Hand Span

- The hand is placed ***palm down*** on a flat surface.
- The fingers are outstretched as far as possible.
- Measure the distance between the ***outside of the thumb*** to the ***outside of the little finger***.



How to Measure Foot Length

- Shoes and socks must be removed.
- Place the most prominent toe and the most prominent part of the heel between two parallel lines that are perpendicular to the foot.
- Measure the distance between the two parallel lines.



Use the measuring procedures described above to complete the following table.

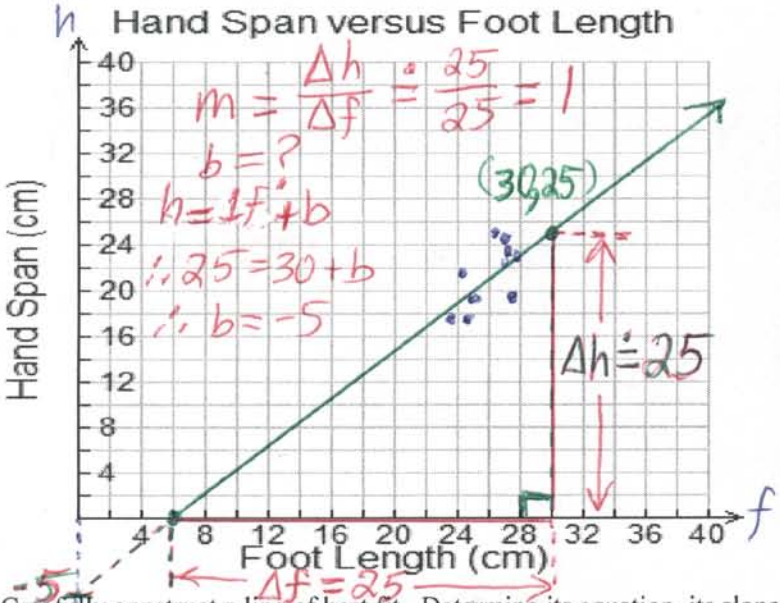
Measure to the nearest millimetre, that is, to one decimal place.

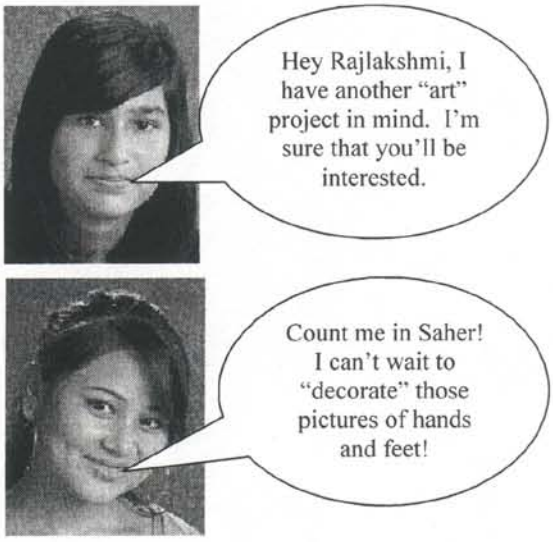
	Student Name	*Foot Length in cm (f)*	*Hand Span in cm (h)*	*Ratio of f : h*
1.	Pablo	27.3	23.9	1.14
2.	Hannah	24.2	20.8	1.16
3.	Kamaljeet	27.9	23.4	1.19
4.	Saher	24.4	17.8	1.37
5.	Meghan	23.9	19.9	1.20
6.	Aditya	26.4	21.1	1.25
7.	Naghan	27.6	21.5	1.28
8.	Gohar	26.8	24.1	1.11
9.	Wafa	23	19.5	1.18
10.	Justin	27.2	22.8	1.19

1.21 Average ratio of f:h

Step Three – Analyzing the Data

(a) Use the data in the table to create a scatter plot.
Do not connect the dots!





(b) Carefully construct a line of best fit. Determine its equation, its slope and its intercepts.

Equation: $h = f - 5$ Slope: 1 Vertical Intercept: -5 Horizontal Intercept: 6

(c) Now use TI-Interactive, a graphing calculator or spreadsheet software to determine the equation of the line of best fit as well as its intercepts. Summarize your results below.

Equation: $h = 0.92f - 2.24$ Slope: 0.92 Vertical Intercept: -2.24 Horizontal Intercept: 2.45

(d) Explain why it is better to use the equation obtained in (c) than it is to use the equation obtained in (b).

It is extremely difficult to sketch a line of best fit with pencil and paper. At best, we can only expect a rough estimate.

(e) Explain the *meaning*, in the context of this problem, of each of the following.

Slope = Constant of Variation = Rate of Change: 0.92 cm of hand span per centimetre of foot length

Vertical Intercept = Initial Value: No meaning in this context since a negative hand span is not possible

Horizontal Intercept: No meaning in this context because it is not possible to have a hand span of zero

(f) Does the data that you collected show a positive correlation, a negative correlation or no correlation? Explain.

There is definitely a positive correlation in the data because hand span increases with foot length.

(g) If you did everything correctly, your line of best fit should have a positive slope. Explain why you would expect this.

Hand span should increase with foot length. This can only happen if the slope (rate of change) is positive.

Step Four – Predicting Shaq's Hand Span

(a) You will use two different methods to predict Shaq's hand span.

Method 1	*Method 2*
Use the equation from (c) in step 3. $h = 0.92f - 2.24$ Shaq: $f \doteq 38$ cm $\therefore h = 0.92(38) - 2.24$ $= 32.72$	Calculate the average of the $f:h$ ratios from the table on the previous page. Then use this average to predict Shaq's hand span. average ratio $= \frac{1.14+1.16+1.19+1.37+1.2+1.25+1.28+1.11}{10}$ $\doteq 1.21$ This means that on average, the foot length is about 1.21 times the hand span, i.e. $f \doteq 1.21h$ $\therefore h \doteq \frac{f}{1.21} = \frac{38}{1.21} = 31.4$
Using method 1, I predict Shaq's hand span to be: about 32.7 cm	Using method 2, I predict Shaq's hand span to be: about 31.4 cm

(b) Predicting Shaq's hand span is an example of ***interpolation*** / ***extrapolation*** **(circle the correct answer)** because

we had to estimate a value BEYOND the range of our data set.

(c) The correct answer to the previous question is "extrapolation." In the space provided below, show an example of ***interpolation*** that involves the data you collected in step 3.

The smallest foot length in the data set is 23 cm and the largest foot length is 27.9 cm. There is no foot length of 26 cm in the data set, so we can interpolate the hand span for a foot length of 26 cm.

Method 1: Equation

$h = 0.92f - 2.24 = 0.92(26) - 2.24$
$\doteq 21.7$

Estimate: Hand span is 21.7 cm

Method 2: Averages

f	h

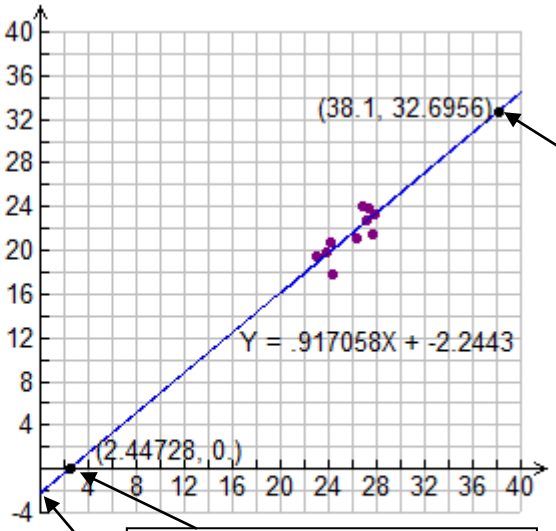
Closest points: (24.4, 17.8), (26.4, 21.1)

Average $= \frac{17.8 + 21.1}{2} \doteq 19.4$

Estimate: 19.4 cm

Line of Best Fit Obtained with TI-Interactive

L1	L2
27.3	23.9
24.2	20.8
27.9	23.4
24.4	17.8
23.9	19.9
26.4	21.1
27.6	21.5
26.8	24.1
23	19.5
27.2	22.8



Linear Regression (ax+b)
regEQ(x) = .917058x + -2.2443

Prediction for Shaquille O'Neal's Hand Span

Foot length was calculated based on Shaq's shoe size: size-23 shoe size → 38.1 cm foot length

Line of best fit predicts a hand span of about 32.7 cm. This is an ***extrapolation***.

Intercepts have no meaning in the context of this scenario. (See step 3, part (e))